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Working Paper Series

#2010-44

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July 2010

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RESEARCH INTO USE: INVESTIGATING THE RELATIONSHIP BETWEEN AGRICULTURAL RESEARCH AND INNOVATION

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Abstract

This paper sets out an analytical framework for doing research on the question of how to use agricultural research for innovation and impact. Its focus is the Research Into Use programme sponsored by the UK's Department for International Development (DFID). This is one example of a new type of international development programme that seeks to find better ways of using research for developmental purposes. The main analytical approach draws on contemporary innovation perspectives and focuses on understanding the ways in which the process of research is used, rather than only on how research products are transferred and adopted. It argues that there is a diversity of ways of organising innovation appropriate to different market, social, technological, institutional and policy niches. The framework developed in the paper is used to frame questions that will help RIU in its quest to provide practical policy with selection guidance in choosing the right sort of innovation support strategies for particular requirements of different niches at different points in the innovation trajectory.

Key words: Agricultural Research, Agricultural Innovation, Innovation Systems, Innovation Narratives, Public Policy, Private Investment

JEL Codes: N5, O13, O19, O22, O31, Q01, Q13, Q16, Q18,

UNU-MERIT Working Papers

ISSN 1871-9872

Maastricht Economic and social Research and training centre on Innovation and Technology, UNU-MERIT

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ACKNOWLEDGMENT

This document is an output from the Research Into Use Programme (RIU) funded by the UK's Department for International Development (DFID) for the benefit of developing countries. The views expressed are not necessarily those of DFID.

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LIST OF ACRONYMS

AKIS	-	Agricultural Knowledge and Information System
CIP	-	Centro Internacional de la Papa (International Potato Centre)
COS	-	Convergence of Science programme
CRT	-	Central Research Team
DFID	-	The UK's Department for International Development
FARA	-	Forum for Agricultural Research for Africa
FIPS-Africa	-	Farm Input Promotions Africa
IFPRI	-	International Food Policy Research Institute
ILRI	-	International Livestock Research Institute
IPM	-	Integrated Pest Management
ISNAR	-	International Service for National Agricultural Research (now retitled the Knowledge, Capacity and Innovation Division)
NARS	-	National Agricultural Research Systems
NERICA	-	New Rice for Africa
NGO	-	Non-Governmental Organisation
Prolinnova	-	Promoting Local Innovation
R&D	-	Research and Development
RIU	-	Research Into Use
RNRRS	-	Renewable Natural Resources Research Strategy
SNM	-	Strategic Niche Management
SRI	-	Systems of Rice Intensification
UK	-	United Kingdom

1. INTRODUCTION

An emerging phenomenon in the international agricultural development community is the idea of *research into use* initiatives. While contours of this idea are still fluid, the factors that have led to its emergence are quite clear. Over the years international agencies, development banks and national governments in developing countries have invested heavily in agricultural research as a way of spurring innovation for social and economic change. Yet, the translation of research into innovation and impact has been patchy, at best.

In the past the response to this problem was to try and improve the efficiency of mechanisms to transfer technologies and other research products to end users. There is, however, wide acceptance that under many circumstances the idea of simply transferring ideas from research to practice does not reflect the way in which innovation actually takes place. The increasing popularity in the international agricultural development community of the heuristic of an innovation system is helping rethink research as part of the wider, complex and dynamic process of innovation (see World Bank, 2006). This, in turn with pressure from the financial backers of research for evidence of impact, is encouraging experimentation with different ways of using research as part of the development process.

The result is the emergence of a new category of innovation-centric agricultural research and development programmes that are piloting research into use-type of ideas. Examples include: the Sub-Saharan Africa challenge programme of the Forum for Agricultural Research for Africa (FARA) which uses the nomenclature of integrated agricultural research for development (see http://www.fara-africa.org/networking-support-projects/ssa-cp/); the Fodder Innovation Project of the International Livestock Research Institute and its partners, which takes as a starting point the ideas that livestock development is hampered not by technological scarcity *per se* but by innovation capacity scarcity (see www.fodderinnovation.org); the Convergence of Science programme of Wageningen University, which experiments with embedding research in wider processes of social and institutional change (see www.cos-sis.org); and the Papa Andina programme of the International Potato Centre (CIP), which has championed a participatory market analysis tool to stimulate innovation in value chains (see www.papandina.org).

Despite the emergence of these type of projects (and there are many others past and present), it is not yet clear how agricultural research should be mapped onto development activities for impact. This is made all the less clear because many of the pilot programmes experimenting in this area end up (unintentionally) becoming advocates for their own approach rather than providing lessons on the wider suite of approaches that might lead to innovation under different circumstances (Hall, 2009). Indeed, what public policy in this area needs is not another new approach, but some practical guidance on which ways of using research for innovation should be supported and under which circumstances.

The focus of this paper is an international development programme that specifically aims to provide these sorts of practical insights. The programme is the Research into Use (RIU) programme (see www.researchintouse.com) sponsored by Department for International Development (DFID) of the UK. The RIU programme has its origins in earlier investments by DFID in agricultural research that supported high quality research, but which were perceived to have unexploited impact potential. RIU was established with the twin purposes of (i) experimenting with ways of achieving impact from previous research at significant scale and (ii) undertaking research into how that process operates.

Part of what is interesting about the programme is that while it started life conceived as a technology transfer programme, it has evolved — through trial, error and review — into something conceptually more in tune with contemporary ideas about innovation (see Hall et al, 2010). It is also noteworthy that RIU represents a new type of programme that hybridises direct and large-scale developmental objects with explicit programme-learning objectives that are formalised through systematic research. This is likely to be an increasingly common mode of operation in future programmes aimed at strengthening innovation. Therefore, the formative experience of RIU has much to offer to others.

The purpose of this paper is to first locate the research of RIU within debates about agricultural research and innovation and to suggest an analytical framework to investigate RIU's central question of how to put research into use. In developing this framework the paper first reviews the way the relationship between agricultural research and innovation has been reconceptualised in recent years and draws six analytical principles from this. It then reviews debates about how to reorganise the relationship between research and innovation. This is used to develop six innovation typologies (described as innovation narratives) to help

identify which approaches are being used under which circumstances. The final sections of the paper outline a comparative research design for exploring the main question of which modes of innovation work best under which circumstances. The guiding analytical principles are then used to frame questions for cases studies that will be the source of evidence for comparative analysis.

Since this task of developing a framework for RIU's research takes place towards the end of the programme's 5-year life cycle the paper ends with a short history of RIU's emergence and evolution and some pointers towards the sorts of lessons that can be expected from it.

2. WHY RESEARCH INTO USE?

Agricultural and natural resources research has been a central tool in international development efforts for the last 50 years. Its achievements include: improving crop and livestock productivity, tackling plant and animal diseases, combating storage pests, improving food safety, and improved and sustainable management of natural resources. Evidence for the social returns to agricultural research and innovation can be traced back to Griliches' pioneering 1958 study of hybrid maize adaption. The work of Alston et al (1998) provides evidence for the consistently high (albeit variable) rates of return to public international agricultural research. While assessing the worth of research in this way has been widely criticised (see Horton and Mackay, 2003), public agricultural research rightly remains an important policy tool. Indeed, after falling out of favour for some time, agricultural research has now regained popularity in the international donor community, with substantial increases in funding to research from the World Bank, some bilateral donors (including DFID), and through the emergence of new donors, most notably the Bill and Melinda Gates Foundation.

Yet, despite its many successes, evaluations of agricultural research programmes have consistently pointed to the disappointing rate of adoption of research products and their relatively modest impact (RNRRS Review, 2005). It is not that agricultural research has failed, but rather that it does not seem to have delivered its full transformative potential. Studies of agricultural innovation point to the fact that research has rarely been a driver of agricultural innovation. Instead, innovation has been driven by entrepreneurs pursuing market opportunities (World Bank, 2006). The International Food Policy Research Institute (IFPRI) recently reviewed the circumstances under which agricultural research has had developmental impact (Spielman and Pandya-Lorch, 2009). It makes the case for the importance of agricultural research, but, importantly, also points to the fact that the story of research and innovation is much more nuanced and that, in fact, research works best when it is complemented by infrastructure development, institutional development, partnerships and policy support. In the same vein there is a longstanding critique of the separation of research from mainstream development assistance activities (Singer et al, 1970; Clark et al, 2003; Hall and Dijkman, 2009).

At the risk of oversimplification, the verdict seems to be that research is necessary but not sufficient: Excellent quality research, but disappointing innovation. In other words, research has been highly successful in generating ideas, developing technologies and expanding the understanding of agriculture-related phenomena and problem areas. However, the track record of using this information for social and economic development — innovation — has proven to be much less straightforward.

3. EXPLANATIONS OF RESEARCH WITHOUT INNOVATION

The paradox of research excellence without innovation is, of course, not a new criticism of agricultural research. These criticisms fall into two categories:

(i) ***Inappropriate Technologies:*** The first category argues that research products — and these may be hard technologies, policy recommendations or new development methodologies — are inappropriate or harmful to the needs of poor farm households. Remedies have focused on fine-tuning the technology design to better suit the resource endowments of farm households. The intermediate technology approaches, for example, gave emphasis to scale of production and potential for self-employment. Alternatively some have advocated for the rejection of certain classes of technology that are perceived to be damaging; for example, the high-yielding, but fertiliser and water-intensive cereals developed for Asia in the 1970s; and biotechnology, particularly genetic modification techniques that have emerged since the 1990s.

(ii) ***Inappropriate Processes of Innovation***. The second category of criticisms argues that it is not the research products or technologies, *per se,* that are the problem, but the process by which these products are developed and put into use. This criticism draws inspiration from three empirical and theoretical observations:

- The first is the observation that successful technical and other types of innovation involve a high degree of user input into design of the technologies and this means that innovation involves the blending of tacit and codified knowledge from different sources. This, therefore, argues against isolated centres of research excellence and makes the case for research to be more embedded in productive activities.
- The second observation is that knowledge only has meaning in the context in which it is used; the implication being that knowledge and innovations cannot simply be transferred to different locations. By the same argument, innovation arrangements and capacities are highly context-specific and take place in a specific historical, political and institutional setting. Therefore, they are not amenable to generalisation and universal application.
- The third observation is that of the political economy of knowledge and knowledge-related processes, which skews innovation trajectories in certain directions. This

implies that specific arrangements and incentives are required to specifically target public and social goals such as poverty reduction or sustainability.

4. RECONCEPTUALISING THE RELATIONSHIP BETWEEN AGRICULTURAL RESEARCH AND INNOVATION

It is the second set of criticisms (see previous section) about the nature of the innovation process that has come to dominate debates about ways in which research can contribute to agricultural innovation and impact. For instance, research planning has progressively tackled this by expanding its view of what constitutes research capacity. In the 1980s the concept of the "National Agricultural Research System" or NARS[4] was developed to guide these investments. Development activities based on the NARS concept have tended to focus on strengthening research capacity, research management and research policy at the national level. In the 1990s the Agricultural Knowledge and Information System[5] (AKIS) gained importance. The AKIS concept recognises the point that besides research there are other ways to generate or get access to knowledge. It emphasises the links between research, education and extension and identifies farmer demand for new technologies (World Bank, 2006).

Although the work of Biggs, Chambers, Röling and others opened the way for rethinking the role of research as part of a wider process of innovation, it has been the idea of an innovation system that has triggered recent retrospection within the international agricultural development community. While not without its shortcomings (Spielman, 2005), as an analytical tool innovation systems has proved to be critical in explaining why research does not necessarily lead to innovation and impact.

The origins of the innovation systems concept are neither in a developing country setting nor in the agricultural sector. Instead the idea emerged in developed economies in the 1980s, where the increasingly knowledge-intensive nature of production meant that conventional economic models that viewed innovation as a linear process driven by the supply of R&D had limited explanatory power and little to offer in terms of guidance for policy-making. This provided the space for the emergence of alternative conceptualisations of the innovation process. Notable were perspectives that understood innovation in more systemic, interactive,

[4] The NARS comprises all a country's entities responsible for organising, coordinating or executing research that contributes explicitly to the development of its agriculture and the maintenance of its natural resource base (ISNAR, 1992).

[5] The Agricultural Knowledge and Information System links people and institutions to promote mutual learning and generate, share and utilise agriculture-related technology, knowledge and information. Such a system integrates farmers, agricultural educators, researchers and extensionists to harness knowledge and information from various sources for improved livelihoods. Farmers are at the heart of this knowledge triangle (World Bank, 2006)

institutional and evolutionary terms. Grounded in an evolutionary economics tradition (Nelson and Winter, 1982), Freeman (1989) and later Lundvall (1991) noticed that the more successful economies had what they described as an effective "National System of Innovation". These systems comprised a combination of linkages or networks and institutional settings that fostered a dynamic process of interaction and learning among scientific and entrepreneurial actors in the public and private sectors in response to evolving economic and technical conditions. The continuous process of innovation that this led to was seen as central to the economic success of countries like Japan in the 1980s.

This idea has been adapted as an analytical tool for developing country research and innovation planning ideas (see, for example, Hall et al, 1998; 2001; World Bank, 2006; Hall, 2006, Spielman, 2008) An innovation system can be defined as networks of organisations or actors — together with the institutions and policies that affect their innovative behaviour and performance — that bring new products, new processes and new forms of organisation into economic use. As an evolutionary model, the focus is on interaction between actors and their embeddedness in an institutional and policy context that influences their innovative behaviour and performance (World Bank, 2006). The main insights from the systems of innovation perspective are summarised in Box 1 below.

Box 1. Insights from the Systems of Innovation Perspective

1. Innovation is a process of using existing and new information/ technology to do something differently/ better/ more efficiently.
2. The motivation to innovate is often the identification of a market/ income opportunity or the need to cope with a new problem (e.g., a new pest problem, a policy change). New technology can often stimulate innovation as it presents opportunities for doing things differently, often in ways not necessarily foreseen by the technology developer.
3. Research is an important source of knowledge/ information/ technology, but its real value only emerges when this knowledge is combined with ideas and practices that come from entrepreneurial and social activity. Embedding of research is thus critical. This is when innovation takes place.
4. As a consequence of point 3 partnership, links and networks become key ingredients in the innovation process as these provide the route for bringing together different ideas and information and using them creatively for innovation.
5. Innovation is process of constant learning and adaptation. Configurations of actors involved changes, depending on the nature of the task at hand. Ways of working are gradually improved. This learning can and often needs to take place at local, institutional and policy levels. This, in turn, implies that technological learning and adaptation are interconnected.
6. While technological artefacts (widgets/ hardware/ reports) can have transformative effects (impacts), much more powerful is the capacity that enables innovation. This has four elements:
    - The expertise of individuals and organisations, which accumulates over time through

both training and experience
    - The routines and ways of doing things, which similarly develop over time through training and trial and error
    - The links, communication channels, and networks that allow individuals and organisations to access a wide array of ideas and expertise for innovation
    - The nature of the policy environment and the way its shapes the first three elements of capacity
7. The direction in which innovation proceeds is often highly dependent on starting conditions as well as historical and political settings. These provide a context in which capacities are to be built (for example, public-private sector collaboration is difficult in India, but accepted in China; producer-funded research arrangements work in Latin America, but not in Sub-Saharan Africa).
8. Unusual and unexpected outcomes often prove to be the most significant and even warrant follow-up and support by projects and policy.
9. In general, innovation proceeds in an unpredictable, non-linear way because it is a response to the unpredictability of markets, climate, pest outbreaks, financial systems and political dynamics. Opportunities and threats arise unexpectedly and being able to reorient quickly to meet these is key to innovation capacity.

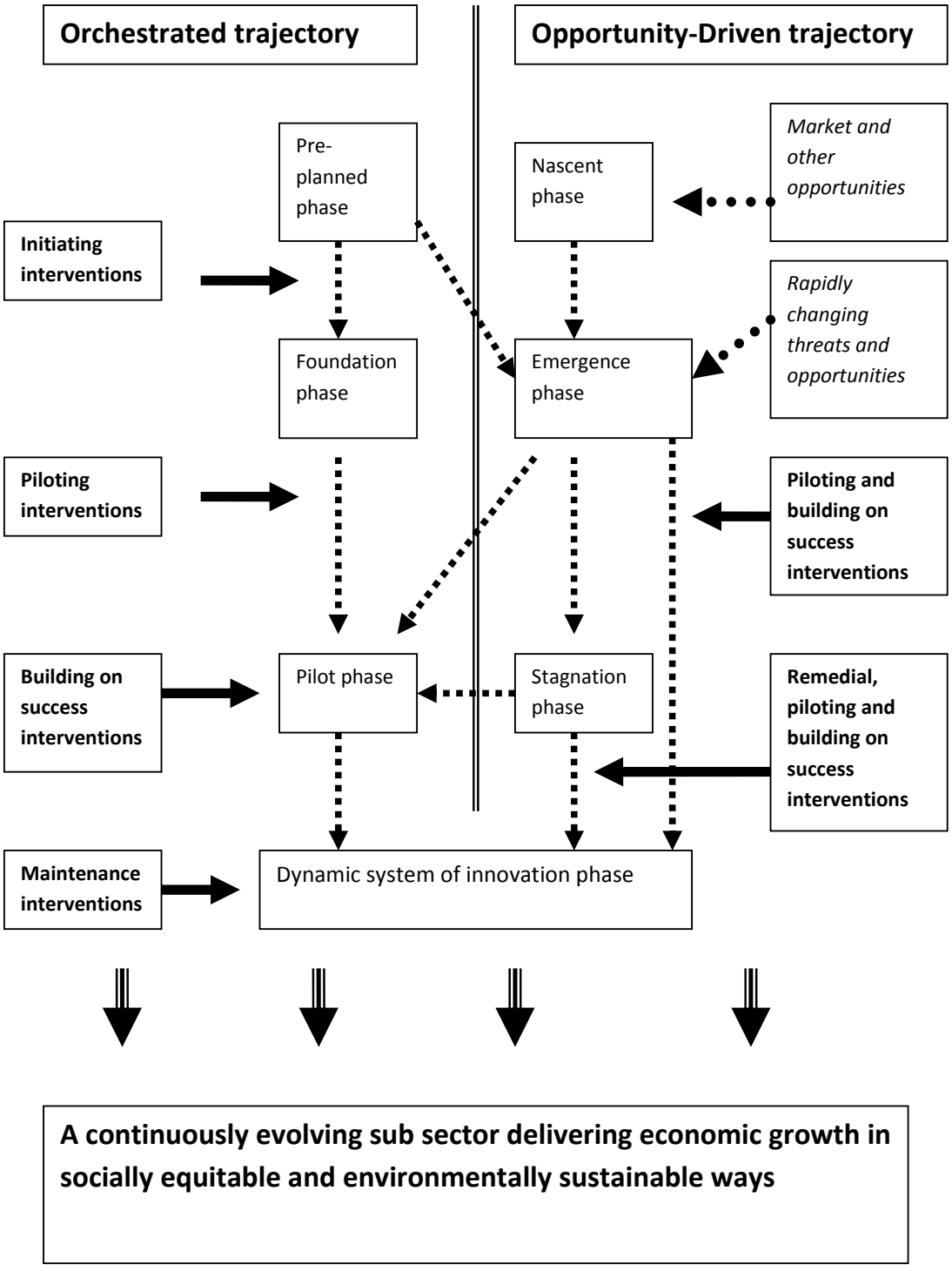
The 'systems of innovation' perspective is based on a very large number of empirical observations of innovation in developed and developing countries and in different sectors, including agriculture. Through these studies a picture of innovation emerges not as a research-centric activity located in scientific organisations, but as an activity distributed through the economy and involving dense networks of interacting players. Examples of empirical observations of innovation in the agriculture sector that have been used to develop this perspective include: Dalohoun el al (2009) described self-organising networks of millers and politicians popularising the use of NERICA rice in West Africa; Biggs and Smith (1998) described the handmade paper industry in Nepal; Clark et al (2003) described a project-based coalition engaged in packaging innovation; Hall et al (2002) described partnerships around mango export in India and micro-irrigation diffusion in Bangladesh (2007); the World Bank (2006) made a comparative analysis of dynamic agricultural sectors in Asia, Africa and Latin America.

The role of research varies in all the above cases. Sometimes it is prominent; sometimes it has been important in the past but is no longer needed. And, in other cases, research is emerging as a key need for dealing with bottlenecks. The great value of the innovation systems idea is that it allows the role and organisation of research to be understood as part of this wider canvas of actors, processes, institutions and policies that are now understood to be involved in innovation.

The attraction of the innovation system idea emerges, however, not only from the holistic and conceptually-convincing explanation of knowledge production and use. It is also because the actors and processes that the concept places emphasis on are becoming increasingly important in the agricultural development landscape. Agricultural development is no longer a production-led process of sciences and farmers developing and adopting new technologies. Contemporary agriculture is not only concerned with staple food production, but also with diversification into new crops, products and markets and value addition to better service those markets. These changes are led by rapid urbanisation and the increasing integration of many developing county agricultural sectors with the global market. Also, social responsibility and environmental sustainability are no longer peripheral issues but are primary concerns of both market and social entrepreneurs in civil society, and this brings in new actors and modes of innovation (Hall, 2010). These perspectives not only underlined the appropriateness of innovation systems ideas to contemporary agricultural development patterns, but once again drew attention to the location of research within a much wider and dynamic system of change.

Another dimension of this perspective emerges from a comparative analysis of the innovating agriculture sub-sector (World Bank, 2006). Challenged with the need to try and guide interventions to support the innovation process the study observed that trajectories of innovation get stuck. This is despite the fact that innovation is usually (initially at least) self-organising through the action of entrepreneurs, opportunity-driven and rarely research-driven (see Figure 1 on the next page). This so-called stagnation phase may take place because networks for accessing knowledge are insufficient. Policy or regulatory issues may be acting as barriers to further innovation. Technology and research may also be barriers; for example, in responding to a crop or animal disease outbreak. This view of innovation as a trajectory unfolding through time helps identify the role and location of research within a dynamic process.

Figure 1:

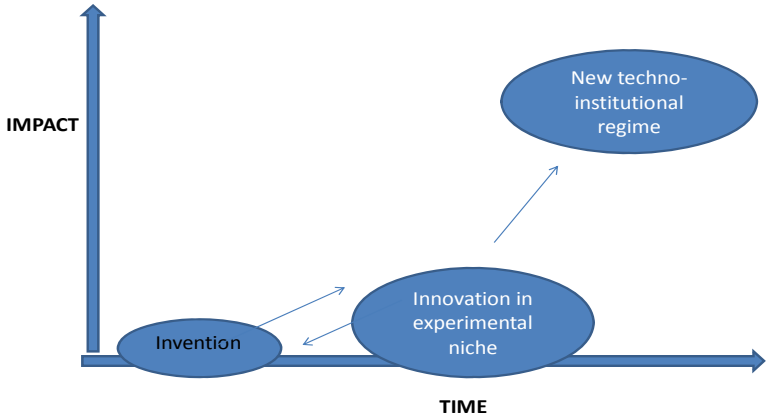

Orchestrated trajectory
Opportunity-Driven trajectory
Pre-planned phase
Nascent phase
Market and other opportunities
Initiating interventions
Foundation phase
Emergence phase
Rapidly changing threats and opportunities
Piloting interventions
Piloting and building on success interventions
Building on success interventions
Pilot phase
Stagnation phase
Remedial, piloting and building on success interventions
Maintenance interventions
Dynamic system of innovation phase
A continuously evolving sub sector delivering economic growth in socially equitable and environmentally sustainable ways

Another useful way of understanding innovation as a dynamic trajectory is the idea of Strategic Niche Management (SNM) (Caniëls et al, 2006; Kemp et al, 1998;). The idea has been developed in relation to the broad socio-technical transition associated with the introduction and diffusion of new sustainable technologies through protected societal experiments in fields such as wind energy, biogas, public transport systems, electric vehicle transport solutions and eco-friendly food production. Agricultural and rural innovation scholars such as Leeuwis have also been using such ideas.

Like the innovation systems idea, this perspective recognises that innovation requires a combination of technical and institutional adaptation. SNM conceptualises this as a socio-technical regime; that is to say a particularly technology or cluster of technologies embedded in organisational, institutional and policy arrangements that allow that technology to be used. The classic example is energy technology in cars. The current techno-institutional regime supports oil-based combustion engine powered cars through a fuel supply infrastructure, pricing and taxation policies as well as an associated research, engineering and innovation capacity tailored to fossil fuel-based energy. The introduction of alternative energy systems, therefore, not only requires technological innovation such as hydrogen-based fuel cell technology (which has already been invented), but also requires a whole set of related changes to usher in a new techno-institutional regime based around this technology (see Mytelka, 2003).

SNM argues that the way innovation takes place is that experimentation takes place in protected niches managed by researchers, civil society organisations or the private sector. This provides a space for technical and institutional testing, refinement and learning. But these innovations do not have wide-scale impacts until they can exert sufficient influence so that the old regime is overthrown and replaced by a new regime that supports the innovation in the niche. Figure 2 (see next page) illustrates this process.

Figure 2:



The parallels with the agricultural sector are easy to spot. Bio-pesticides is one such example where the technological innovation can only have wide-scale impact if is supported with a new techno-institutional regime that includes new modes of regulatory approval and new production and supply chains. Participatory plant breeding is another example where regime changes are needed in terms of seed release and certification policies as well as professional norms among plant breeders. Dorman et al (2007) document the way in which introducing soil fertility technology to support cocoa production in Ghana was dependent on regime changes in terms of both land tenure arrangements and norms and standards in cocoa market chains.

The protected innovation niches that SNM conceptualises are very similar to pilot projects associated with agricultural research and rural development. Similarly, the innovation niche is similar to a range of early stage entrepreneurial activity. What this conceptualisation brings to the understanding of the relationship between research and innovation is the critical importance of regime changes, not only as a way of putting research into use, but also as a way of having impact at scale. Put another way, the reasons why research is not having impact is that even if it is used in experimental niches, unless additional efforts are made to change the wider regime little wide-scale impact is likely to occur. This sheds much light on

the poor performance of agricultural research to date. It also provides two important insights for those wanting to make more out of research.

Firstly, investments and partnerships are required to couple technological innovation with institutional change. This almost certainly implies a specific set of intermediation activities aimed at advocating and negotiating institutional and policy changes. This is a role that increasingly falls under the term 'innovation brokering' (Klerkx et al, 2009).

Secondly, if you are interested in tracking the socio-economic impact of research and innovation, changes in the techno-institutional regime are a starting point. It makes no sense to look for direct impact from activities in the innovation niche as the purpose of this domain is technical and institutional learning. Activities here may or may not have direct social and economic impact, partially at least because failure here is a form of learning. But even if impacts are detected in this domain they cannot be extrapolated to predict long-term impact on society unless changes in the techno-institutional regime are also detected. So while it is valid to track the socio-economic impact of changes in techno-institutional regimes, it makes little sense to do so before this takes place. A useful approach is to track the likelihood that regime change is underway using indicators of institutional change. To make the same point differently it is useful to track the extent to which activities and interventions with potential for social gain are disrupting dominant techno-institutional regimes

Guiding Analytical Principles from the Reconceptulisation of the Relationship between Research and Innovation

The above discussion of the main trends in the reconceptualisation of the relationship between agricultural research and innovation points to 6 guiding analytical principles:

1) **Embedding:** The first principle concerns the recognition that putting research into use is not simply an idea of how to transfer research products into use, but is actually about how to use the research process (including its expertise, products, modes of discovery, accumulated knowledge). This is an important principle because it shifts the analysis from a narrow focus on technology diffusion, to a broad focus on understanding the location of the research process as part of a wider process of innovation. As we have already discussed before, this

embeddedness perspective point to the need to investigate actors, roles, institutional settings and the enabling environment.

2) **Context**: The second and related principle is that the way of embedding research in the innovation process is dependent on the context in which all this is taking place. This context might be the physical location and the sorts of organisations that operate in this location. It might be the nature of the opportunity or challenge being addressed. It might be the technology involved; and it might be the political and cultural setting and history of a particularly country. Analytically this means that it is important to explore the research into use question in a comparative way, as this helps account for the specific or individual cases and identify generalisable patterns and principles. The other analytical perspective that comes from this is that it is useful to recognise the sorts of social and market niches in which research into use for innovation in starting to take place. This allows for the investigation of the relationship between generic context and broad approaches that work in these contexts.
3) **Diversity:** The third principle follows from the importance of context and this is the recognition that rather than there being a single best way of putting research into use there is likely to be a wide diversity. This, in conjunction with that of the context-specific nature of this process, mean that the analysis must focus first on exploring the range of ways of using research for innovation and then trying to understand the circumstances (social and market niches) when broad categories of approaches are appropriate.
4) **Agency:** The fourth principle relates to the recognition that innovation is a social process, whereby individuals and organisations respond to challenges and opportunities. Classic innovation studies have pinpointed this as the role of the company innovating in response to the market. More accurately it is the role of entrepreneurship (in its many forms) driving innovation to achieve various market, social or environmental gains. In understanding how research is put into use a critical analytical perspective is the identification of the individuals and organisations through whose agency innovation takes place. This is also analytically important in terms of understanding the governance patterns that accompany entrepreneurs (some seeking profit, some seeking social and environmental change) and which determine the distribution aspects of innovation impact (Hall, 2010).

5) **Temporality:** The fifth principle responds to the observation that innovation involves different phases and that different approaches to it are required at different points of time as the innovation trajectory unfolds. Analytically this is important, not because it necessarily means there is a sequence of modes of innovation, but because it simply recognises that certain approaches and interventions are going to be important for putting research into use at different points in time during an innovation trajectory.

6) **Outcomes at Multiple Levels:** The sixth principle reflects the idea that innovation involves an interlinked set of adaptations throughout the techno-institutional regime — i.e., technical and institutional changes at the local level, but also at the systems level, which allows for wider-scale local level changes. Since, in theory, regime changes can take place through the learning arising from both successes and failures in local innovation process, one analytical implication is that welfare outcomes are not a useful indicator of impact (at least not in the immediate term). Instead impact of programmes is best tracked through changes in the techno-institutional regime. The logical conclusion of this analytical principle is that welfare changes can only be measured at a population level once these changes have been in place for some time. A useful way to analyse this may be to identify the extent to which initiatives and projects are disrupting the dominant techno-institutional regime — for example, the promotion of micro-seed and fertiliser packs, causing an industry-wide change in marketing strategies.

5. REORGANISING THE RELATIONSHIP BETWEEN AGRICULTURAL RESEARCH AND INNOVATION

Over the last 30 years the critique of research without innovation has led to the suggestion of a range of alternative and complementary ways of organising innovation. These deploy research in different ways and to varying extents. As we have already been at pains to point out, these are not presented as competing approaches, but rather as an illustration of the sorts of perspectives that are starting to impinge on the common policy narrative. It is also important to note that these are not mutually exclusive options, but that there is much overlap. What the following highlights is the diversity of ways of organising agricultural innovation that have been discussed in the literature on the topic.

Participatory Technology Development: Farmers should be at the centre of the innovation process as they have superior knowledge of their production and social context. The role of research is peripheral, although Biggs (1990) points to a number of variants of participatory research with different degrees of farmer involvement and different roles for research (Chambers et al, 1989, but also Scoones et al, 2009). Falling within this approach are many variants — client-orientated breeding (Witcombe et al, 2006), Farmer Field Schools (Röling and van de Fliert 1994; Van den Berg, 2004).

Promotion of Local Innovation: The Honeybee network (http://www.sristi.org/hbnew/) of Anil Gupta in India pioneered the idea that rural communities are the primary sources of agricultural innovation and there are untapped innovations that can be promoted more widely. The international network known by its acronym Prolinnova (http://www.prolinnova.net/) is another variant of this perspective and sees the role of research as sometimes in the validation of farmer technologies as well as in the form of support services to local innovation (Sanginga et al, 2008)

Innovation Governance: The voice of poor communities is not heard in agricultural science and technology planning. Power dynamics are skewed towards vested interests in both the scientific community and the corporate world. Remedies include the establishment of citizen panels, citizen juries and the expansion of participation in foresight and scenario planning exercises that address the power dynamics in research, technology and innovation (Leach et al, 2005; Fairhead and Leach, 2004, Sussex Manifesto, 2010).

Multiple Sources of Innovation: Knowledge needed for innovation does not just come from research but from multiple sources, including farmers, but also the private sector. Arrangements linking different sources of knowledge are highly dependent on historical and socio-political contexts (Biggs, 1990). If these links can be strengthened innovation will proceed and research will be more effective.

Nurturing Promising Innovation Processes: Markets — and the opportunities they present to poor people — are leading the emergence of new types of innovation processes and products. There are also innovation processes that are invisible to research and corporate communities due to alternative professional views of excellence and success — e.g., Systems of Rice Intensification or SRI (Shambhu Prasad, 2006), treadle pumps (Hall et al, 2007), etc. These are described variously as bottom-of-the-pyramid innovation (Prahalad, 2004), bottom-up bottom-line business models (Hall et al, 2010) below-the-radar innovation (Kaplinsky et al, 2009). All of this suggests that the role of policy is not to orchestrate innovation processes and capacities. Rather, it is to scan for emerging capacities and processes with social significance and support their expansion.

Innovation Capacity Building: The rate limiting step in technical change is not technology development or promotion, *per se*, but the degree of development of innovation capacity. This capacity is viewed in a systems sense as the behaviours of loose networks of innovation-related players and the institutional and policy settings that shape their behaviour and evolution. Interventions focus on exploring how these networked capacities can be developed through experimentation and learning (Hall et al, 2007).

Multiple Roles for Research: There are many different roles for research in the innovation process (Hall, 2005). Sometimes it is a source of creativity, supplying new technologies, approaches or policies (the common view). Sometimes, it is a responsive, problem-solving source of expertise. Other times it is a way of structuring learning around broad problem areas such as health or environment. In turn, each role requires different configurations of the wider innovation process in which research is embedded (Hall, 2008).

Public-Private Sector Partnerships: The private sector has not played an adequate role with regards to agricultural research and allied activities. It sometimes has research expertise of its

own. It also has incentives, structures and mechanisms to deliver demanded technologies to consumers (farmers, but also others in the value chain). A greater role for the private sector in innovation can be achieved by providing incentives for partners (Byerlee and Echeverría, 2002) and by developing social capital between companies and other elements of the agricultural innovation system (Hall, 2006).

Financing Innovation: Financial resources are key incentives for innovation and, increasingly, are being used to encourage the development of new partnership configurations around specific problem areas and research products. Innovation prize funds, public buy-back for privately-developed products, challenge funds and venture capital-type arrangements are examples of this (Sonne, 2010).

Communication: Research products need to be processed into forms suited to different audiences and made accessible through databases. This is particularly important for policy-orientated research, where concise and timely information can play a critical role in decision-making. In the wider innovation process communication is increasingly viewed as a means of intermediation between different players and viewpoints and less as a tool for transferring information (Leeuwis and Pyburn, 2002). This has highlighted the importance of an intermediation or role for innovation brokers to act as connectors between different parts of an innovation system.

None of these is superior and rather than being seen as competing approaches they should be seen as overlapping and complementary configurations that embed research into the innovation process in different circumstances and at different points in time. Recent thinking on agricultural innovation stresses the importance of expanding this repertoire and diversity of innovation configurations, arguing that all of these are needed to tackle an expanding set of challenges and opportunities faced by the agricultural sector (Hall, 2009).

Perhaps notable by its absence from this list is innovation systems as a clearly delineated approach. As has been discussed innovation systems is simply a heuristic to reveal the complex nature of innovation as a socially-embedded process of learning and change. None of the above falls outside what this way of thinking would value as a valid mode of innovation in a larger repertoire of approaches. The question of research into use is not whether any of the above is a better way to get research into use. Instead, the research

question for RIU is when, and under what circumstances, do these different approaches become more or less useful in making the best use of agricultural research as a policy instrument for development.

6. A TYPOLOGY OF WAYS OF ORGANISING AGRICULTURAL RESEARCH FOR INNOVATION: INNOVATION NARRATIVES

To create a manageable set of operational options a set of stylised typologies or innovation narratives has been distilled into the range of modes of enabling innovation that are discussed in current literature. The term narrative is used here in the sense of a common policy narrative that becomes an accepted way of doing things (Keeley and Scoones, 2003). The purpose of these narratives is to help identify which modes of innovation are being used to put research into use and to aid comparative analysis of these in different circumstances. In other words, the narratives are a device for categorising the main ways in which agricultural research is being organising evidence.

Innovation Narratives

1) **Poor User-Led Innovation.** Approaches that place poor farmers and consumers at the centre of the innovation process as they have superior knowledge of their production and social context. *Examples*: participatory research; participatory plant breeding; and local innovation support programmes.
2) **Public-Private Partnership-Led Innovation**. Approaches that seek to deploy the expertise, resources and entrepreneurial perspectives of the private sector in an alliance with public actors and policies. *Examples*: research and development alliances; private companies supplying goods and services; business incubation.
3) **Capacity Development-Led Innovation**. Approaches with a focus on institutional and network development with a view to enhancing innovation system capacity. *Examples*: innovation platforms; network strengthening initiatives; innovation brokering; policy dialogue platforms and processes.
4) **Below-the-Radar-Led Innovation.** Approaches that seek to nurture emerging innovation models that focus on the opportunities presented by large markets of poor people at the intersect of market and social entrepreneurship. *Examples*: use of social venture capital arrangements to identify and support business models that combine market-led and social entrepreneurship.
5) **Investment-Led Innovation.** Approaches that rely on financial incentives for innovation through a variety of operational forms. *Examples*: challenge funds; social venture capital funds.

6) **Communication-Led Innovation.** Approaches that use communication as an intermediation tool for technical and institutional adaptation. *Examples*: use of ICT and media to strengthen the transmission and availability of ideas to different audiences; network building; and negotiating institutional policy change at the regime level.

7. KEY QUESTIONS FOR PUBLIC POLICY AND PRIVATE INVESTMENT

International agencies, national governments — broadly, public policy — and private capital wishing to invest in activities that better link research to innovation are faced with one overarching question: Which way of organising innovation will work best under what circumstances and at what point in the innovation trajectory. Public policy further needs to answer the question of which ways for organising innovation will best deliver policy ambitions such as social development, economic growth and environmental sustainability. The private sector, on the other hand, needs to identify the approaches and circumstances under which it can achieve its objective of making profit. This can either be profit as a sole objective or in combination with social and environmental objectives, depending on the nature of the entrepreneurs involved and the business model adopted.

There is a further consideration for public. The innovation narratives presented in the previous section represent a menu of options that public policy can choose from. However, there is also an important question about how it uses these options. Figure 1 in Section 3 contrasts two main innovation trajectories. The first is an orchestrated trajectory where various public policy instruments, such as research as well as development projects and programmes, are used in an attempt to drive innovation. The second is a self-organising, opportunity-driven trajectory. In this sector case public policy plays a supportive role to initiatives that have already been started by private capital and different modes of entrepreneurship.

This means that the menu of options contained in the 6 innovation narratives can either be used in an orchestrated way or in an opportunity-driven way, supporting initiatives that are already underway (although clearly some owe their origins more to orchestrated thinking). Clearly, the six ways of organising innovation stylised in our narratives are going to be used in quite different ways, depending on whether these are deployed in an orchestrated mode or in support of opportunity-driven processes.

A wider implication of this for research on this topic is that public policy will need help to understand when it is useful to take a more orchestrated approach and when it is more appropriate to support opportunity-driven entrepreneurial activity. A research question here is

the prevalence of self-organising hotspots of opportunity-driven innovation in a particular country or regional setting. For example, countries like Bangladesh, with a strong civil society tradition, have an abundance of opportunity-driven entrepreneurship with high social relevance. Ethiopia, on the other hand, which has a strong tradition of state orchestration, does not. This, therefore, provides a filter for selecting options and modes of use. The question of prevalence is not only useful for public policy but is also important for private investment planning — which circumstances is one likely to see a critical mass of investment opportunities in, for instance.

8. RESEARCH DESIGN AND QUESTIONS

One of the guiding analytical principles outlined in Section 3 is the importance of context and analytical value of undertaking comparative analysis to draw out broad patterns. To understand how the guiding analytical principles outlined in Section 4 and the innovation narratives outlined in Section 6 will be used to frame questions for a comparative investigation of ways of organising innovation it is first necessary to introduce the nature of the activities within the RIU programme.

There are three broad types of interventions in RIU, each of which has different variants within it. These are as follows:

Post-Research Project: These are known in RIU as the Asia Innovation challenge fund projects. These are modest-scale projects which build on earlier research by project teams in India, Bangladesh and Nepal. The alliances involved have often been expanded to include more non-research actors. The hypothesis behind these activities is that existing research findings can be put into use through efforts to popularise or commercialise them. Within this category are three main sub-categories of projects: Natural Resource Management Innovation, Value Chain Innovation and Plant Breeding Institutional Innovation.

Orchestration Pilots: These are known in RIU as the Africa country programmes and these operate in Sierra Leone, Nigeria, Tanzania, Rwanda, Malawi and Zambia. The projects involve specific efforts to establish mechanisms to broker alliances around opportunities. This involves the intervention of the country offices to establish innovation platforms as a device for identifying opportunities and partners. These platforms take a variety of forms in different country settings. The hypothesis behind this approach is that currently there is a missing role of brokering that is not present in the innovation support services of most countries. Piloting this role could not only broker alliances and build experience of this way of working, but it could also help persuade national policy to invest in this sort of role being played by either public or private sector organisations.

Support to Opportunity-Driven Initiatives: These are known in RIU as the African Best Bets and involve support to six enterprise-based initiatives (some are companies and some are development consortia) located in East Africa. All cases involve business models that

respond to a combination of market, technical and social opportunities. RIU support usually involves pump-priming markets of poor people for the products and services that these initiatives can then sell. The hypothesis is that by correctly identifying business models with social relevance, financial, research and technical and other modes of incubation support can help these initiatives succeed and, in the process, achieve large developmental impacts.

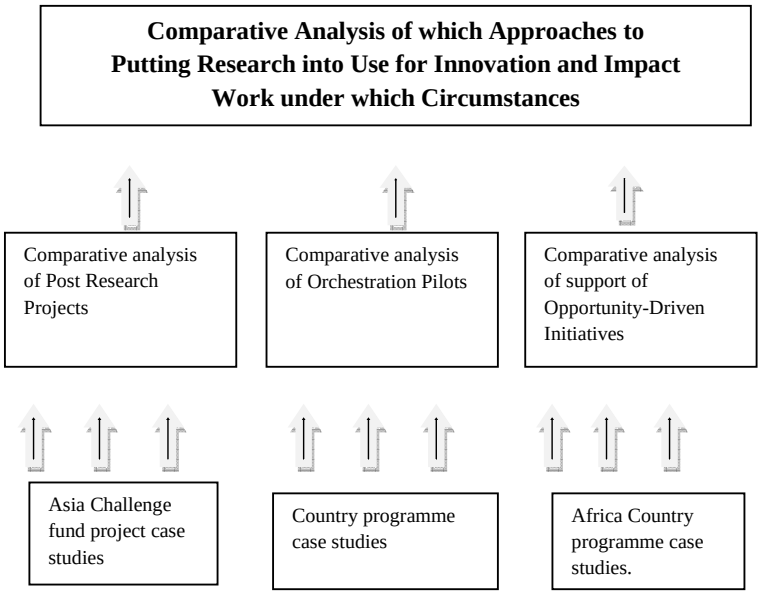
The research design of RIU for exploring the circumstances under which different ways of organising innovation to put research into use involves a comparative analysis stylised in Table 1 below. Note that within each of the three broad categories of RIU intervention comparative analysis will also be necessary; for example, between the different Africa country programmes. This cascading comparative analysis is illustrated in Figure 3 (see next page).

Table 1. Matrix of Comparative Analysis of Innovation Narratives in Different Categories of RIU Experiments

	Post Research Projects (Asia challenge fund projects)	**Orchestration Pilots** (Africa country programmes)	**Supporting Opportunity-Driven Initiatives** (Africa Best Bets)
Poor User-Led Innovation	**	*	
Public-Private Partnership/ Agro-Enterprise-Led Innovation	**	**	**
Capacity Development-Led innovation	*	**	*
Below the Radar-Led Innovation			**
Investment-Led Innovation	*	*	**
Communication-Led Innovation	*(Knowledge management)	*communication for innovation	* (Communication for innovation and knowledge management)

Contribution of evidence to innovation narrative: ** = Primary * = secondary
Note: Communication as intermediation to facilitate innovation is implicit in all cases, so all will be contributing to this narrative.

Figure 3. Cascading Comparative Analysis Research Design



Within the comparative framework mentioned above, which will be used for organising evidence and undertaking comparative analysis, specific research questions need to be answered to develop that evidence. In the case of the RIU programme the project, country programmes and Best Bet initiatives will be the unit of analysis. For each a case study will be undertaken. The analytical principles outlined in Section 3 guide how those questions should be framed. Key questions for each case study are as follows:

Embedding: What role does research play in the initiative? Has it already been completed or is research continuing in parallel? What is its focus and has it changed? Is research used for technical backstopping and troubleshooting? How is research linked to the initiative; as a partner and collaborator or as a paid-for service provider? Is the initiative led by a researcher who now plays a championing or entrepreneurial role?

Context: What is the niche that the initiative is located in? This may be a market niche**;** for example, the growing demand for traditional food in African urban areas. It may be a technological niche; for example, the development of new bio-control agents. It may be an institutional niche; for example, the degree of social organisation or a strong history of

collaborative action. Or it may be a policy niche; for example, policy liberalisation for new forms of microfinancing. Or it may be a combination of all of these.

Diversity: Choosing from the menu of options in the six innovation narratives, what modes of organising innovation are dominant? If one is more important than the others how has this changed over time and why? Are these modes of innovation being used as part of an orchestrated initiative or are they pragmatic practices arising from different forms for entrepreneurship and associated business models? How pervasive are these business models and do they offer the opportunity for private investment or blended public-private sector investments? Are there any notable features about the way they are being used for specific purposes — players involved, ways of working, choice of partners, etc.? What factors and actions support different modes of innovation? What factors and actions impede them?

Agency: Who is driving or championing the initiative and for what purposes — profit, social development or environmental sustainability, for example? In cases where champions are pursuing a combination of these objectives how do they manage the trade-offs? What are the specific activities that are undertaken by these champions to operationalise the mode of innovation they are deploying? What tasks and skills are required? Are there differences apparent in orchestrated pilots compared to opportunity-driven initiatives?

Temporality: What is the history and evolution of the initiative and what shaped this evolution? What stage of the innovation trajectory has it reached? Are initiatives and business models at the point of being financially sustainable or will they need further incubation? Will they need to rely on a blend of market-based and public purse revenues? What are the specific characteristics of this current phase and how to these relate to the modes of innovation that are being deployed? Are there any roadblocks currently or expected in the near future, which are likely to shape the future trajectory?

Outcomes at Multiple Levels: What has been the intended economic, social and/or environmental outcome of the initiative? Is there any evidence that it can achieve any of these outcomes? What changes in the techno-institutional regime does the initiative need to achieve for longer term and/or wider scale success? Is there any evidence that the initiative is disrupting the dominant or current techno-institutional regime? What strategies have been used to achieve this disruption and what are the indicators of this change?

To illustrate what this research design will look like in practice the following table (Table 3) presents what has been seen so far in RIU. It is anticipated that this list of niches will be expanded as RIU's innovation studies proceed. What is already apparent at this early stage is that no *one* approach outlined in the innovation narratives detailed in Section 6 will fit in any *one* niche. Rather, we expect to see a bundling of these different approaches. The main output of RIU's research will be a ready-reckoner to help planners and private investors make choices cognisant of both the approaches needed as well as the risks involved and the likely returns in terms of both financial rewards and social impact.

Table 2:

Market, Social, Technical, Institutional and Policy Niches	**Bundles of Innovation Approaches**
Strong urban demand for traditional foods	**Orchestration Pilots**: Private sector supplying production inputs to farmers organised by the development sector. E.g., Poultry Development, Tanzania
Standards and norms in international value chains that create expertises and services applicable to poor farmers	**Supporting Opportunity-Led Initiatives**: Private companies sell products and services to poor markets incubated with public funds and development organisation assistance. E.g., Real IPM, bio-control of striga, Kenya
Upgrading of traditional commodity markets	**Orchestration Pilots and Supporting Opportunity-Led Initiatives:** Intermediary organisations from the public and private sectors brokering access to private sector-organised input and output markets. Policy lobbying by the private sector. E.g., Cowpea and soybean, Nigeria; FIPS's small seed and fertiliser packs in East Africa
Policy windows associated with reform of tertiary education	**Supporting Opportunity-Led Initiatives:** University graduate scheme that promotes business-led technical services. E.g., Sleeping sickness control in Uganda
Increasing effective demand of large numbers of poor people for goods and services	**Usually Supporting Opportunity-Led Initiatives:** Public and private sectors invest in pro-poor business models that rely on

	user-led models of innovation. E.g., Real IPM; FIPS in East Africa; Fish seed in Asia; Client-Orientated Breeding in Asia
Value chains with governance for ethical niche markets	**Supporting Opportunity-Led Initiatives:** Private and development sectors partner with producer-owned enterprises to link to lucrative markets. E.g., Value chain development projects in India and Nepal
High degree of social organisation for development purposes	**Supporting Opportunity-Led Initiatives:** Development and private sectors partner to build on the existence of groups of poor people organised for different purposes. E.g., Microfinance for innovation in India
Social capital from historically-developed, multi-sector alliances for development purposes	**Both Supporting Opportunity-Led Initiatives and Post-Research Projects:** Reconfiguration of consortia for public good mobilises public, private and development actors, resources and services. E.g., Army worm control, East Africa; Flood Plain Management, Bangladesh

9. CONCLUSION

This paper sets out an analytical framework for doing research on the question of how to use agricultural research for innovation and impact. It holds out the promise of being able to provide some practical help to research and development planners who wish to extract better impact from investments in agricultural research and allied activities. The analytical framework presented here will not deliver the best way to do this. However, it will help planners select the range of options needed under different circumstances. This would be a major improvement over the ‘universal’ solutions to the problem of research into use that have been so common in the past and which have failed so dismally to deliver impact.

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